FOREST PEST MANAGEMENT

DISTRIBUTION OF ARMILLARIA ROOT DISEASE IN THE BLACK HILLS

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ABSTRACT

A survey for armillaria root disease in the Black Hills of South Dakota was conducted in summer 1990. The disease occurred in most parts of this region (34 of 44 townships), and its incidence and severity varied among sites. High disease incidence occurred at or near Lower Spearfish Canyon, Black Hills Experimental Forest, Twin Sisters, Moon Campground, and Gooseberry Draw.

INTRODUCTION

Armillaria root disease, caused by various Armillaria (Fr.) Staude spp., received little attention in the Black Hills of South Dakota until the early 1970s, when seedlings in a ponderosa pine (Pinus ponderosa Dougl. ex Laws) provenance trial died from infection (unpublished Research Report 1971). Although the provenance trial was eventually abandoned and infected trees were found in other research plots, the importance of this disease regionwide is unknown. Only two published studies in the Black Hills have dealt with it. Hinds et al. (1984) and Lessard et al. (1985) investigated the association of root disease infected trees with attack of mountain pine beetle (Dendroctonus ponderosae Hopkins). Their data suggest that this root disease is more widely distributed and probably more important than previously thought. The aim of the study was to determine the distribution of armillaria root disease throughout the Black Hills.

MATERIALS AND METHODS

A roadside survey of disease incidence and severity was conducted in September and October of 1990. Roads were systematically chosen to cover most of the Black Hills National Forest. Possible disease sites were located by spotting dead and dying trees at a distance. These trees were inspected by removing the bark at the root collar and upper roots and looking for mycelial fans and rhizomorphs of Armillaria spp. Sites where Armillaria was found on trees were marked on a map. Fruiting bodies were found in a few cases during early September.

To evaluate disease intensity and visualize large scale geographic patterns of disease distribution, the number of sightings in each township was divided into the road miles surveyed and disease incidence was calculated as the average number of sightings per mile in each township. Lines were drawn to connect townships with similar degrees of root disease incidence, resulting in an "isobar" type map.

Firm conclusions are difficult to draw from roadside surveys because only trees visible from the road are assessed. These trees may not be representative of those further away. The Black Hills, however, are extensively roaded because of mining and logging activities. Most locations are easily accessible; thus, sufficient information probably was collected to draw inference about disease distribution.

RESULTS AND DISCUSSION

Armillaria occurred in most parts of the Black Hills, although disease incidence varied. Three hundred thirty sightings were made along 200 miles of forest road. The disease was found in 34 of the 44 townships (Table 1).

Table 1. Sites in the Black Hills (Ranger Districts and legal descriptions) where armillaria root disease was found on ponderosa pine (Pinus ponderosa), quaking aspen (Populus tremuloides) and white spruce (Picea glauca).

Pinus ponderosa

Spearfish RD	T5NR1E Sec 1, 20, 22
	T5NR2E Sec 6
	T6NR2E Sec 30, 31
	T4NR2E Sec 17, 19, 20
	T4NR1E Sec 2, 3, 6, 7, 8, 10, 15, 18, 20, 21, 22, 25
	T4NR1E Sec 26, 27, 28, 31, 33, 34
	T3NR1E Sec 6, 7, 8, 10, 17, 18, 19, 20, 35, 36
	T3NR2E Sec 3, 4, 9, 10, 16, 17, 18
	T3NR2E Sec 29, 30, 31, 33
Nemo RD	T5NR5E Sec 31,
	T4NR5E Sec 5, 6, 8, 16, 29
	T4NR4E Sec 1
	T3NR2E Sec 24, 16, 17
	T3NR3E Sec 13, 17, 19
	T3NR3E Sec 24, 25
	T3NR4E Sec 1
	T3NR5E Sec 7
	T2NR3E Sec 4
	T2NR4E Sec 11
	T2NR5E Sec 8, 9, 16, 17
Elk Mt. RD	T2NR1E Sec 1, 2, 11, 13
	T2NR1E Sec 23, 36
	T1NR1E Sec 16, 22, 34, 36
	T1SR1E Sec 3, 9, 15, 22, 23, 24, 28
	T2SR1E Sec 16, 21, 24
	T2SR2E Sec 19
Pactola RD	T2NR2E Sec 20, 21, 28, 33, 34
	T2NR4E Sec 13, 14, 15
	T2NR4E Sec 22
	T1NR5E Sec 7, 11, 13, 16
	T1NR6E Sec 18, 19, 20, 29, 30, 32
Harney RD	T2NR3E Sec 22, 23, 27, 31, 32
	T1NR2E Sec 2, 3, 11, 12, 27, 32, 33, 34, 35, 36
	T1NR3E Sec 17, 21
	T1SR2E Sec 19, 28, 29, 36
	T1SR3E Sec 11, 12, 13, 14, 26
	T1SR4E Sec 5, 6, 7, 8, 17, 18, 20, 27, 29, 32, 33, 34
	T2SR3E Sec 8, 13, 16, 17, 20, 24, 28
	T2SR4E Sec 3, 4, 6, 7, 9, 16, 19
	T3SR2E Sec 1
Custer RD	T2SR4E Sec 3, 4, 8
	T3SR4E Sec 17, 18
	T3SR2E Sec 14, 16
	T3SR3E Sec 2, 3, 4, 9, 10, 11, 12, 14, 15, 16, 28, 33
	T4SR2E Sec 12, 26

Bearlodge RD	T55NR63W Sec 36
	T54NR63W Sec 1, 12
	T54NR62W Sec 18
	T53NR63W Sec 1, 33
	T52NR63W Sec 5, 8, 17, 18, 20, 33

Populus tremuloides

Nemo RD	T4NR4E Sec 1, 13
	T3NR3E Sec 26
	T2NR4E Sec 19
Spearfish RD	T4NR1E Sec 21
	T3NR2E Sec 29, 33
Elk Mt. RD	T2NR1E Sec 13
	T2NR1E Sec 23, 35
	T1SR1E Sec 9, 21
Pactola RD	T2NR2E Sec 28
Harney RD	T1NR2E Sec 27, 35
	T2SR2E Sec 1, 2
	T2SR3E Sec 12

Picea glauca

Spearfish RD	T3NR1E Sec 36
	T3NR2E Sec 18, 29, 31, 33, 34
Nemo RD	T3NR2E Sec 27
	T3NR3E Sec 21, 30
	T2NR4E Sec 22, 29, 30
Elk Mt. RD	T2NR1E Sec 23, 25
Pactola RD	T2NR2E Sec 29
Harney RD	T1NR2E Sec 32

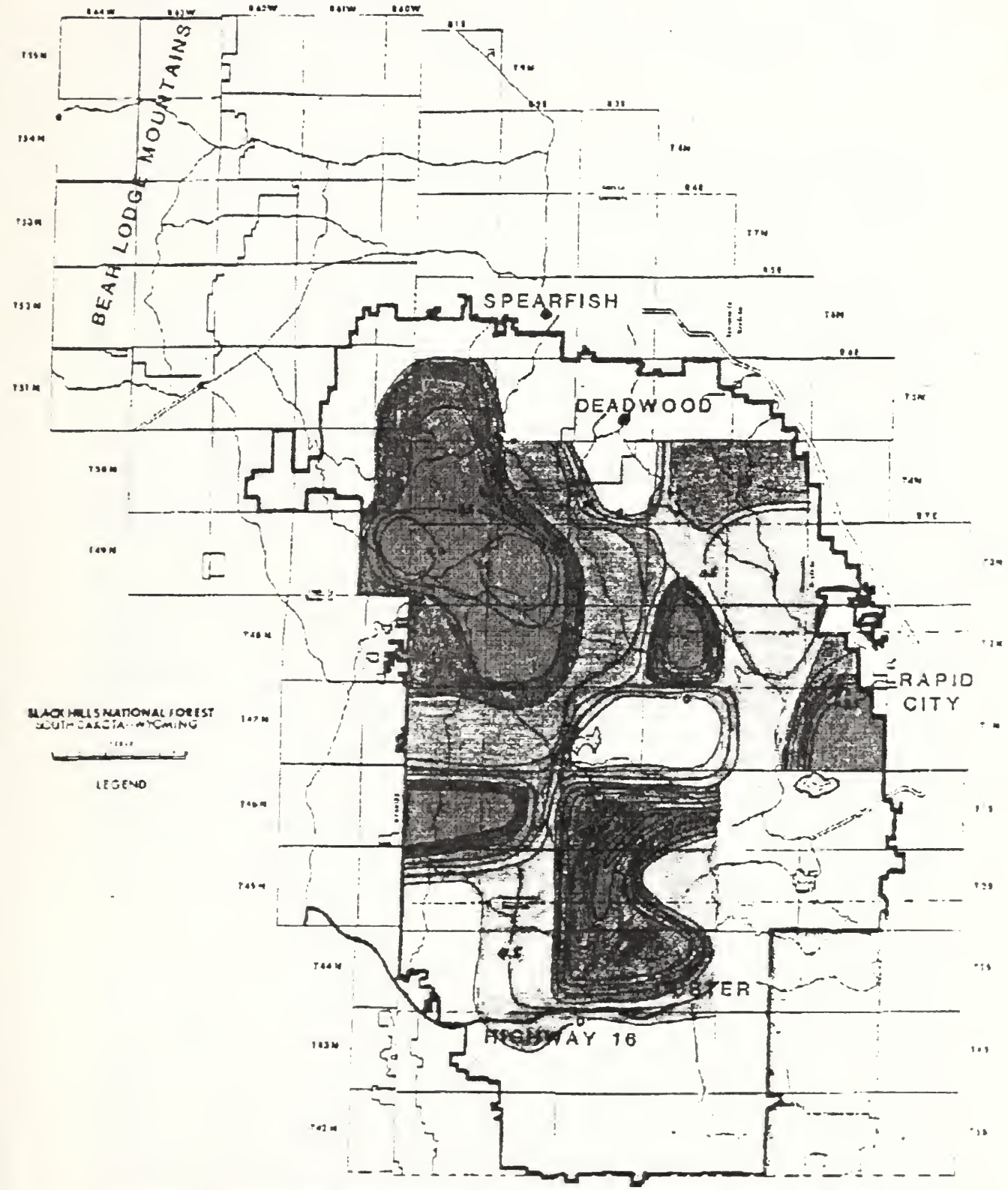

Figure 1. Distribution of armillaria root disease in the Black Hills. Lines connect areas of similar disease incidence. Colors indicate the following levels of disease incidence, expressed in number of disease sightings per mile surveyed: No Color: 0; Yellow: >0 - 1.0; Brown: >1.0 - 2.0; Blue: >2.0 - 3.0, and Red:3.0.

Disease incidence ranged from 0 to 4.2 sites/mile. Five areas of high incidence (> 3 sites/mile) were found (Figure 1). These were at Lower Spearfish Canyon (T4NR1E, T3NR1E, T3NR2E, T2NR2E, T49NR60W), Experimental Forest (T2NR4E), Twin Sisters (T1NR6E), Moon Campground (T1SR1E), and Gooseberry Draw (T1SR4E, T1SR2E, T2SR3E). Troughs of low incidence occurred between these peaks of high incidence. A prominent trough of low incidence diagonally crosses the Black Hills from the northeast to southwest. A southern limit to disease distribution parallels Highway 16.

The disease distribution map (Figure 1) can be used as an indicator of disease hazard. Areas marked in red or blue on this map indicate places of high hazard. On the other hand, the map also indicates regions where armillaria root disease should not be a problem. Further surveys may discover other high hazard sites within low hazard areas.

Early in the survey, two types of disease patterns were detected: 1. individual dead and dying trees scattered throughout a stand, or 2. dead and dying trees more or less grouped together with individual trees within the group showing various stages of degradation. During the survey, a distinction was noted between these two patterns.

A comparison of diagrams showing scattered (Figure 2) and clumped (Figure 3) distributions of disease indicates that one pattern dominates in many places. For example, the Experimental Forest and Twin Sisters contains primarily scattered stand infections, whereas Moon Campground has clumped infections. Lower Spearfish Canyon and Gooseberry Draw have both.

The nature of these infection patterns could be related to several factors. For example, their distribution could be related to differences in pathogen virulence. The number and identity of Armillaria species present in the Black Hills is unknown. The distributions may parallel those of Armillaria species or clones showing different pathogenic abilities, an attribute not uncommon in Armillaria (Shaw and Kile 1991). Furthermore, the distributions may be influenced by various stresses. Stands with scattered infection patterns appeared to be associated with stem wounding and soil disturbance caused by logging, fire, or bark beetles. Clumped infections were commonly observed in areas of past bark beetle outbreaks and salvage cuts and it was usually difficult to determine which agent most influenced the infection pattern. Moreover, Armillaria might have invaded the roots only after trees had died.

The two disease patterns may represent phases in a sequential continuum. For instance, thinning operations may allow extensions of Armillaria into scattered trees in a stand (Filip et al. 1998). Subsequently, bark beetles may attack these trees and thus sustain a low population in the forest ecosystem (J. Schmidt, personal communication). Following some trigger (e.g., drought), beetle populations expand and kill neighboring trees. As more trees die from beetle attacks, Armillaria sp. colonizes more and more roots, until the inoculum loads allow for disease spread even after the beetle infestation has passed. In this way, management activities could be converting stands with little or no disease incidence to higher hazard sites. Closer examination of the effects of harvest practices on the distribution and spread of armillaria root disease in the Black Hills is warranted.

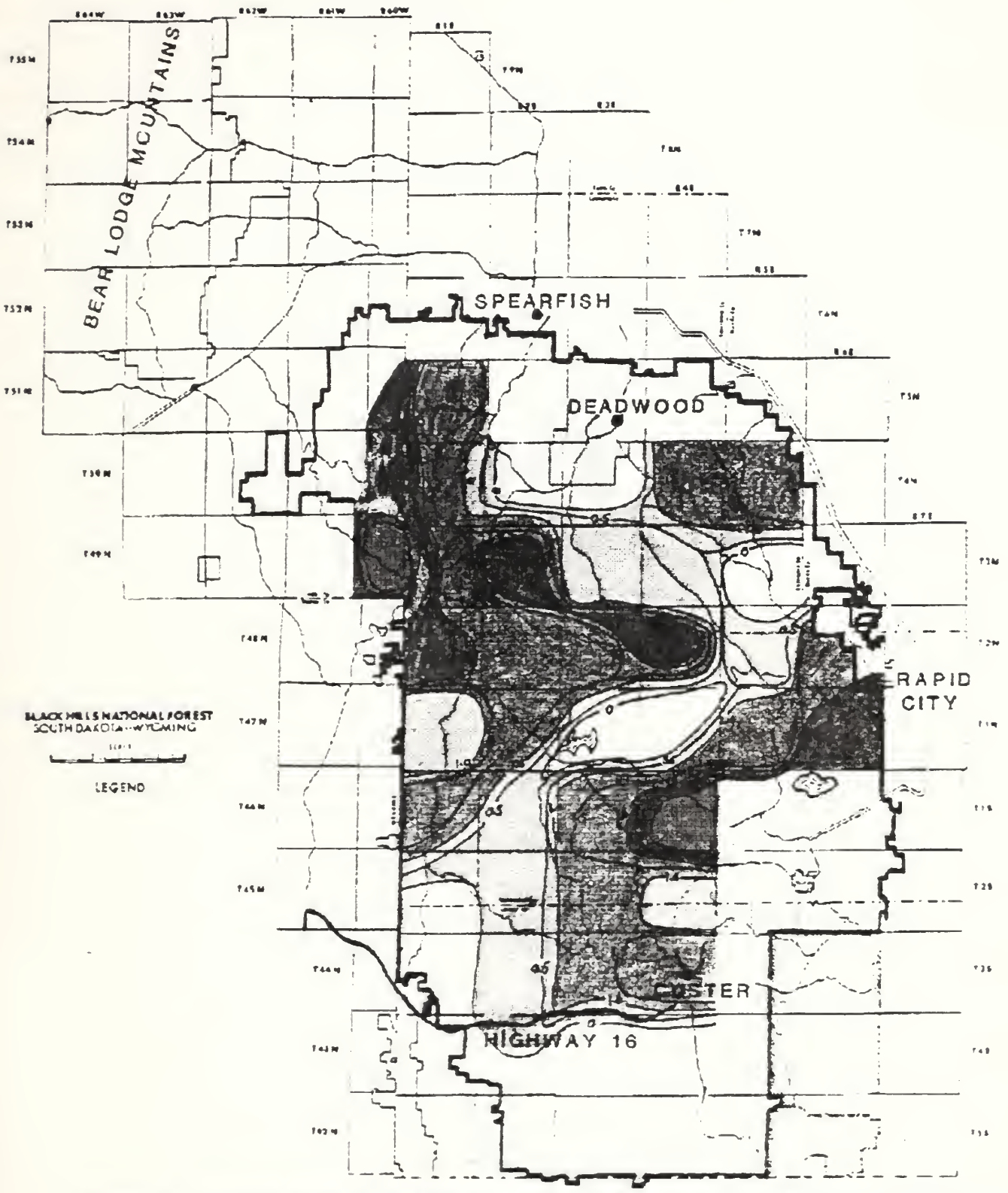

Figure 2. Distribution of stands in which scattered trees were found infected with armillaria root disease. Lines connect areas of similar disease intensity. Colors indicate the following levels of disease incidence expressed in number of disease sightings per road mile surveyed: No color: 0; Yellow: >0 - 1.0; Brown: >1.0 - 2.0; Blue: >2.0 - 3.0; and Red: >3.0.

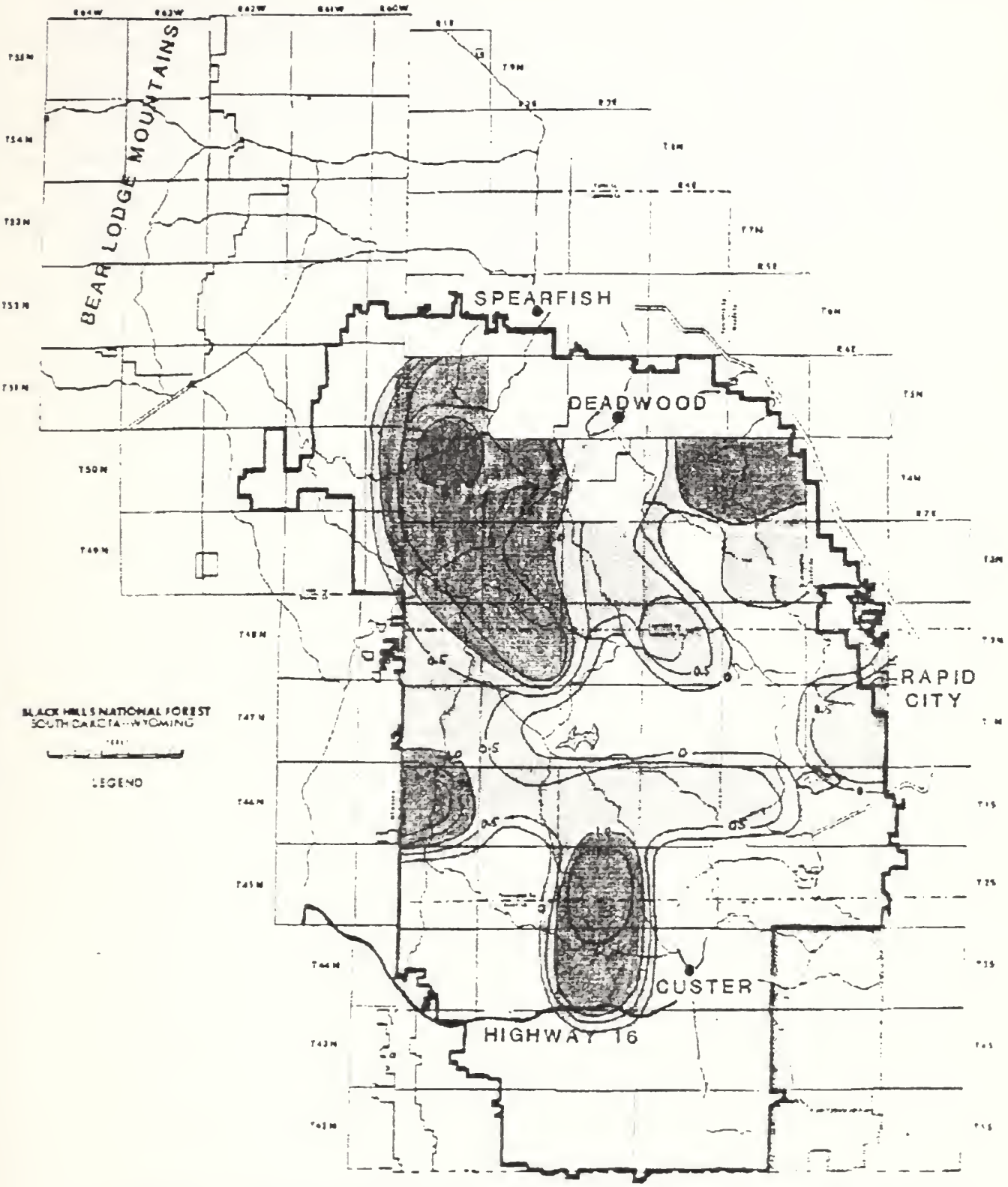

Figure 3. Distribution of stands in which clusters of trees were found infected with armillaria root disease. Lines connect areas of similar disease intensity. Colors indicate the following levels of disease incidence, expressed in number of disease sightings per road mile surveyed. No color. 0, Yellow. >0 - 1.0, Brown. >1.0 - 2.0, Blue. >2.0 - 3.0, and Red. >3.0.

Despite being widely distributed, the actual impact of armillaria root disease in the Black Hills is still unknown. The relationship between disease incidence and resource values (including fiber yields) need to be studied. Until more predictive tools are developed and tested, management should seriously consider alternatives to the establishment of stands for fiber production in high hazard sites. This disease and the stresses with which it is often associated are insiduous; they work over long periods of time, are not easily eliminated, and enhance plant and animal diversity within infected stands. One alternative on high hazard sites may be to manage for biodiversity or wildlife habitat. In fact, it is conceivable that circumstances will arise in which root disease will provide management benefits.

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